Living Waters

Conserving the source of life

The Economic Values of the World's Wetlands

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Left: *Water lilies in the Kaw-Roura Nature Reserve, French Guyana. These wetlands were declared a nature reserve in 1998, and cover area of 100,000 hectares. Kaw-Roura is also a Ramsar site.*

Summary

Wetlands are ecosystems that provide numerous goods and services that have an economic value, not only to the local population living in its periphery but also to communities living outside the wetland area. They are important sources for food, fresh water and building materials and provide valuable services such as water treatment and erosion control. The estimates in this paper show, for example, that unvegetated sediment wetlands like the Dutch Wadden Sea and the Rufiji Delta in Tanzania have the highest median economic values of all wetland types at $374 per hectare per year.

Furthermore, the provision by wetlands of recreational opportunities and amenities, and flood control and storm buffering are the wetland functions with the highest median economic values at $492 and $464 per hectare per year respectively. The economic value of wetlands per geographical region was also estimated, which showed that Asian wetlands have the highest economic values at $1.8 billion per year. Lastly, an attempt was made at estimating the economic value of global wetlands, which showed that $3.4 billion is a very conservative estimate of this economic value. The two main reasons for this conservative estimate are that (1) many wetland functions were not valued in the economic valuation studies collected and used for this value; and (2) only a fraction of the world's global wetland area was used (63 million hectares), the reason being that this is currently the best available database. If, on the other hand, we extrapolate this estimate to the area cited by the Ramsar Convention of a global wetland area of 12.8 million km^2, the total economic value of the world's wetlands is in the order of $70 billion per year. **The report's conclusions are based on a snapshot of available data on wetland areas and of case studies of wetland economic values, and the report's conclusions could be enhanced as more data becomes available**.

The estimates derived in this paper illustrate the magnitude of the economic value of global wetlands in addition to their biodiversity, scientific value, climate regulation, potential tourism, socio-cultural and other important wetland values. They represent one more tool to raise awareness with decision-makers about the economic benefits of conserving or restoring and sustainably managing wetlands as opposed to their degradation and reclamation. Rather than mosquito-invested swamps, wetlands are highly valuable ecosystems on which large amounts of populations depend economically and get water for basic functions.

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Above: *The culture of Lotus flowers is common in the Province of Hunan, China. The leaves, the flowers and the seeds are used as food and the beauty of the flowers is much valued.*

Despite their economic value, wetlands all over the world are continually modified and reclaimed at great cost. While others are being restored at great cost also. The root cause of much wetland degradation is information failure - decision-makers often have insufficient understanding of the values of wetlands, including the economic value, so the protection of wetlands does not appear to be a serious alternative. Therefore, the message of this paper must be conveyed to decision-makers across the world so that they may recognize this economic value and put their efforts in more sustainable management of the world's wetlands to the benefit of society.

Introduction

This paper presents an overview of initial economic values of the world's wetlands. The basis for this study is the database of global wetland economic values as developed by the Institute for Environmental Studies (IVM) in Amsterdam.

Left: Okavango Delta, Botswana. Boy of the Mabokushu tribe with fish in his dugout canoe.

This database contains 89 economic valuation studies across continents. Over the past years, many economic valuation studies of wetlands around the world have been carried out by different organizations. These studies include valuations of specific wetland sites (for examples, see the case studies presented in this report), but also studies that provide overviews of economic values of wetlands based on illustrative case studies (see for example "The Socioeconomics of Wetlands" by Stuip et al., 2002 [1] and "Money Grows on Water" by IUCN Water & Nature Initiative, 2003 [2]). However, a comprehensive overview of wetland economic values across continents globally is lacking. One attempt at measuring the global economic value of wetlands was made by Costanza et al. [3] in 1997, which estimated the total economic value of the world's biomes at $33 trillion and the economic value of the world's wetlands at $4.8 trillion. However, although interesting and relevant for the message it conveyed and subsequent discussion it stimulated, these figures are very crude approximations[1] that introduced a lot of errors and the study was heavily criticized for its calculations. No distinctions were made between economic values of wetlands in different geographical regions, values of different wetland types or values of different wetland goods and services. The underlying study is intended to further refine these distinctions and to extrapolate them to the world's wetlands.

This paper combines relevant economic valuation studies carried out around the globe to provide ranges of estimates for wetland economic values by geographical region and by wetland good or service. This study also conducts a 'value transfer' (the prediction or estimation of the value of a wetland given the knowledge of its physical and socio-economic characteristics) to initially estimate the global economic value of wetlands. These estimates are intended to clarify for policy makers that wetlands are economically valuable biomes that provide goods and services upon which many communities and economies depend. Recognizing the economic importance of wetlands in addition to their biodiversity, scientific value, climate regulation, potential tourism, socio-cultural and other important wetland values (that were not included in the calculations in this study) is yet another good reason to reverse global wetland loss and can help meet the U.N Millennium goals to halve the number of people without adequate water and sanitation services by 2015, and significantly reduce the rate of loss of biodiversity by 2010.

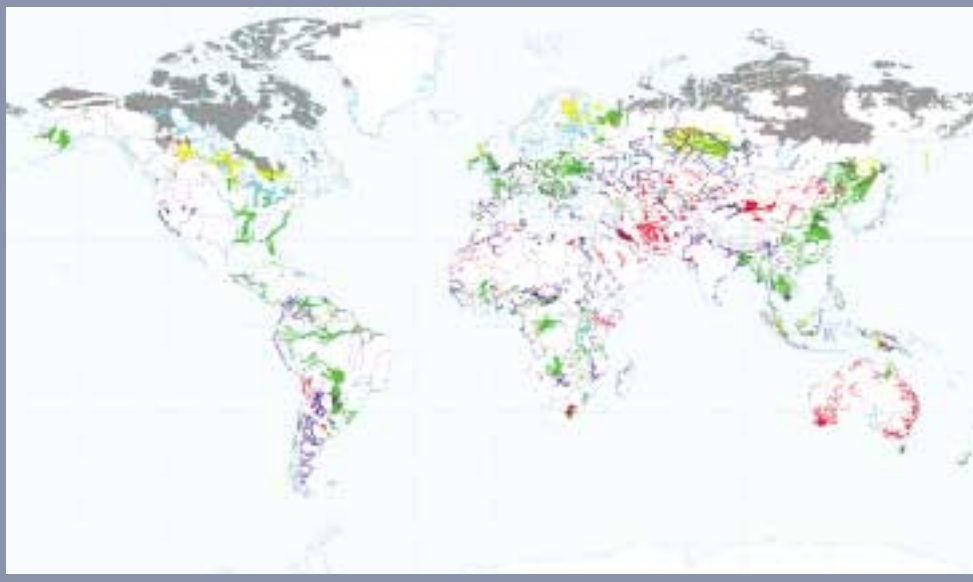
[1] *The calculations were based on estimates of one per hectare wetland value for all wetlands around the world, and then multiplied by the total area of wetlands.*

Economic Values of the World's Wetlands

What are Wetlands?

Wetlands are valuable ecosystems that occupy about 6% of the world's land surface (see Figure 1). They comprise both land ecosystems that are strongly influenced by water, and aquatic ecosystems with special characteristics due to shallowness and proximity to land[2] [4]. Although various different classifications of wetlands exist, a useful approach is one provided by the Ramsar Convention on Wetlands. It divides wetlands into three main categories of wetland habitats: (1) marine/coastal wetlands; (2) inland wetlands; (3) man-made wetlands. The marine and coastal wetlands include estuaries, inter-tidal marshes, brackish, saline and freshwater lagoons, mangrove swamps, as well as coral reefs and rocky marine shores such as sea cliffs. Inland wetlands refer to such areas as lakes, rivers, streams and creeks, waterfalls, marshes, peat lands and flooded meadows. Lastly, man-made wetlands include canals, aquaculture ponds, water storage areas and even wastewater treatment areas. Figure 1 shows the distribution of wetlands around the world.

Figure 1:
Global Distribution of Wetlands



- *Upland*
- *Lowland*
- *Organic*
- *Salt affected*
- *Permafrost affected*
- *Inland water bodies*
- *No Wetlands (or too small to display)*

Source: US Department of Agriculture, Natural Resources Conservation Services, 1997[27]

[2]The official definition proposed by the Ramsar Convention (1971) reads that wetlands are "...areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres".

Values

Functions and Values of Wetlands

The classification of wetlands made in the previous section emphasizes the immense diversity of wetlands. At the same time, wetlands also perform an enormous variety of functions [5]. First, wetlands perform **regulation functions** - wetlands regulate ecological processes that contribute to a healthy environment. Examples are recycling of nutrients and human waste, watershed protection and climate regulation. A second function of wetlands is called **carrier function**: wetlands provide space for activities such as human settlement, cultivation, energy production and habitat for animals. Third, wetlands perform **production functions**. Wetlands provide resources for people such as food, water, raw materials for building and clothing. The last wetland function is **information function** in the sense that wetlands contribute to mental health by providing scientific, aesthetic and spiritual information. Box 1 provides a list of key wetland functions.

The diversity in functions that wetlands perform makes them incredibly valuable ecosystems. For example, they have a very high **ecological value**, providing the water and primary productivity upon which countless species of plants and animals depend. Wetlands support high concentrations of birds, mammals, reptiles, amphibians, fish and invertebrate species. It has been estimated that freshwater wetlands hold more than 40% of all the world's species and 12% of all animal species [6]. Individual wetlands can be extremely important in supporting high numbers of endemic species; for example, Lake Tanganyika in Central Africa supports 632 endemic animal species [6].

Box 1: **Wetland Functions**

Regulation Functions	*Storage and recycling of nutrients*
	Storage and recycling of human waste
	Storage and recycling of organic waste
	Groundwater recharge
	Groundwater discharge
	Natural flood control and flow regulation
	Erosion control
	Salinity control
	Water treatment
	Climatic stabilization
	Carbon sequestration
	Maintenance of migration and nursery habitats
	Maintenance of ecosystem stability
	Maintenance of integrity of other ecosystems
	Maintenance of biological and genetic diversity
Carrier Functions	*Agriculture, irrigation*
	Stock farming (grazing)
	Wildlife cropping/resources
	Transport
	Energy production
	Tourism and recreation
	Human habitation and settlements
	Habitat and nursery for plant and animal species
Production Functions	*Water*
	Food
	Fuel wood
	Medicinal resources
	Genetic resources
	Raw materials for building, construction and industrial use
Information Functions	*Research, education and monitoring*
	Uniqueness, rarity or naturalness and role in cultural heritage

Many wetlands also have an important **socio-cultural value**. Although this value is still relatively unexplored, it is known that wetlands have religious and historical values for many local communities. For example, in Australia many wetlands have a cultural value to their Aboriginal owners, in which they conduct ceremonies and semi-traditional hunting and gathering. In other parts of the world, wetlands are used to conduct initiation rites and in Hong Kong the Mai Poi marshes are the only place where residents can watch traditional methods of shrimp cultivation. Certain studies have shown that more than 30% of 603 Ramsar wetland sites examined had archaeological, historical, cultural, religious, mythical or artistic/creative significance[3] [6].

Lastly, wetlands also provide populations with numerous goods and services that have a significant **economic value**, not only to the local population living in its periphery but also to communities living outside the wetland area. Examples of valuable wetland goods are fish, reeds and papyrus, birds and wild animals and fresh water. The staple diet of 3 billion people, half the world's population, is rice, which grows in wetlands in many parts of the world. In addition, wetlands provide a nursery habitat for many commercially important fish species that are harvested outside the wetland. Important wetland services include the provision of recreational opportunities and amenities, nutrient recycling, storm protection and flood control. For example, New York City found that it could avoid spending $3-8 billion on new waste water treatment plants by investing $1.5 billion in buying land around the reservoirs upstate as well as instituting other protective measures to protect the watershed that will do the job of purifying the water supply for free [31]. This constitutes a significant amount of money saved.

Above: *A worker carrying harvested reeds which are used in paper production in China.*

[3]See The Cultural Heritage of Wetlands information pack available from the Ramsar Bureau for more information on socio-cultural values of wetlands.

Economic Values

Economic values are usually distinguished as use and non-use values [7]. Economic **use values** of wetlands comprise the direct use of a wetland's goods, such as the consumption of fish for food, trees for fuel wood or as a building material, and water for drinking, cooking and washing. Use values also include the indirect use of a wetland's services, such as water retention capacity (including man-made for irrigation or energy production) and nutrient recycling. Lastly, option value can be distinguished as a use value - this is defined as the value of a wetland to humans to preserve an environment as a potential benefit for themselves in the future. For example, some people would be willing to pay for the conservation of a tropical rainforest as a potential source of medicine against diseases like cancer and AIDS. The **non-use value** of a wetland refers to the non-instrumental value, not associated with use. This includes existence value - a recognition of the value of the very existence of wetlands. For example, some people may have sympathy with or concern for the welfare of certain animals - a desire that certain species should exist. These people would then be willing to pay for the conservation of this species. The appendix briefly discusses the process of economic valuation.

The remainder of this section will illustrate economic values of wetlands with selected case studies in which such values have been measured in different continents in the world. It should be kept in mind that in every valuation study the economic values presented are not necessarily absolute values, but dependent on contextual factors of both the wetland area (population densities, income levels, etc.) and the study itself (such as the valuation method applied, availability of information, the time and budget constraints imposed on such studies and so on). These factors may cause economic values between wetlands to diverge in addition to the difference in absolute wetland economic value. It must also be noted that economic values in certain wetlands may be based on full utilization of the wetland economic potential, while economic values of other wetlands are not. For example, tourism development in certain wetlands may be currently under-exploited and therefore not reflected in their economic value. Therefore, the economic values in the following cases (as most economic values) should be viewed as orders of magnitude. Furthermore, it must again be stressed that **economic value is only a fraction of total wetland value**, which also comprises biodiversity, scientific, climate regulation, socio-cultural and other important wetland values, as was discussed at the beginning of this section. **While certain wetlands may appear to have low economic values in comparison to others (see for example the Pantanal below in comparison to the Charles River basin wetlands), it must be kept in mind that such wetlands may have enormous ecological values and socio-cultural values (such as the Pantanal)[4]. Hence, conservation and sustainable management of wetlands should be based on total wetland value and not economic value alone.**

[4]It must also be noted that wetlands such as the Pantanal and many others attract funding from bilateral and multilateral donors for conservation and community based natural resource management projects. This constitutes a 'willingness-to-pay' by the international community for the conservation and sustainable management of wetlands, implying considerable economic value. These type of figures are, however, not included in the estimates in the examples in this section.

Economic Value of the Pantanal, Brazil [8]

The Pantanal in Brazil is the world's largest freshwater wetland - a 138,000 km^2 tropical seasonal wetland in the centre of South America. It is divided into eleven sub-regions, and this study focuses on the largest of these - Nhecolandia (19.5% of the region). It is of immense biological significance and was recently designated a United Nations World Heritage site.

The economic values of the enormous variety of the Pantanal's goods and services as well as its total economic value is presented in Table 1.

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Table 1:
Economic Value of the Pantanal Wetland, Brazil

Ecosystem Service	Economic Value per year (millions, 1994 US$)
Gas regulation	181.31
Climate regulation	120.50
Disturbance regulation	4,703.61
Water regulation	1,019.82
Water supply	5,322.58
Erosion control	170.70
Soil formation	60.22
Nutrient recycling	498.21
Waste treatment	1,359.64
Pollination	33.03
Biological control	30.39
Habitat/refugia	285.04
Food production	143.76
Raw materials	202.03
Genetic resources	22.15
Recreation	423.64
Cultural	1,144.49
TOTAL ECONOMIC VALUE	15,644.09

Economic Value of the Lake Chilwa Wetland, Malawi [9]

The Lake Chilwa wetland has an area of 2,400 km^2 and is situated in the south of Malawi, on the border with Mozambique. It is one of the most productive lakes in Africa - it produces more than 20% of all fish caught in Malawi. It is also a very important area for breeding waterfowl and for agricultural activities.

The two major threats facing the Lake Chilwa wetland are a reduction in lake level due to abstraction within the catchment and degradation of the catchment. Over-trapping and shooting of resident and migratory birds is also a major problem. Potential threats for the future include population increase, soil erosion and siltation, destruction of breeding grounds and sanctuaries for fish, increased use of agro-chemicals affecting the aquatic environment and invasion by exotic plant species.

The economic values of the Lake Chilwa wetland's goods and services and its total economic value are shown in Table 2.

Table 2:
Economic Values of the Lake Chilwa Wetland, Malawi

Wetland Good or Service	Economic Value per Year (converted to 2002 US$)
Agricultural grounds	1,293,802
Fish	18,675,478
Vegetation	13,457
Open water	435,668
Grasslands	637,987
TOTAL ECONOMIC VALUE	21,056,392

Economic Value of the Muthurajawela Wetland, Sri Lanka [10]

The Muthurajawela Marsh covers an area of 3,068 hectares, and is located near Colombo, the capital of Sri Lanka. It forms a coastal wetland together with the Negombo Lagoon. It is rich in biodiversity and in 1996 part of the wetland was declared a Wetland Sanctuary. The pressures facing the Muthurajawela wetland are growing. Major threats are urban, residential, recreational, agricultural and industrial developments; over-harvesting of wetland species; and pollution from industrial and domestic wastes. As a result, the wetland has been seriously degraded.

The economic values and total economic value of the Muthurajawela wetland are illustrated in Table 3.

Table 3:
Economic Value of the Muthurajawela Wetland, Sri Lanka

Economic Benefit	Economic Value per year (converted to 2003 US$)
Flood attenuation	5,033,800
Industrial wastewater treatment	1,682,841
Agricultural production	314,049
Support to downstream fisheries	207,361
Firewood	82,530
Fishing	64,904
Leisure and recreation	54,743
Domestic sewage treatment	44,790
Freshwater supplies for local populations	39,191
Carbon sequestration	8,087
TOTAL ECONOMIC VALUE	7,532,297

Economic value of the Dutch Wadden Sea, The Netherlands [11]

The Dutch Wadden Sea is an estuarine environment covering an area of 270 thousand hectares. It is located in the north of the Netherlands between six barrier islands and the Dutch coast. The Wadden Sea consists of extensive tidal mudflats, salt marshes, wet meadows, reclaimed polders, sandbanks, and dune systems. The area is important for numerous species of breeding, wintering and staging water birds and supports several notable plant species. Tourism is an important activity in the area. The Wadden Sea's economic values are presented in table 4.

Table 4:
Economic Value of the Dutch Wadden Sea, The Netherlands

Economic Benefit	Economic Value per year (converted to 2003 US$)
Flood prevention	189,000,000
Storage and recycling of organic matter	756,000,000
Storage and recycling of nutrients	945,000,000
Habitat and nursery	45,360,000
Nature protection	5,670,000
Aquaculture	8,316,000
Recreation	189,000,000
Food	170,100,000
Raw materials for construction	9,450,000
Spiritual / historical information	5,670,000
Education and scientific information	6,048,000
TOTAL ECONOMIC VALUE	2,329,614,000

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Economic value of Whangamarino wetland, North Island, New Zealand [12]

Whangamarino wetland is the second largest peat bog and swamp complex on North Island, New Zealand. It is the most important breeding area in New Zealand for Botaurus poiciloptilus (a species of heron) and a habitat for wintering birds and a diverse invertebrate fauna. The wetland covers an area of 10,320 hectares and supports a commercial fishery, cattle grazing, recreational activities. Estimated use and non-use values for Whangamarino are presented in Table 5.

Table 5:
Economic Value of Whangamarino wetland, New Zealand

Economic Benefit	Economic Value per year (converted to 2003 US$)
Non-use preservation	7,247,117
Recreation	2,022,720
Commercial fishing	10,518
Flood control	601,037
TOTAL	**9,881392**

Economic value of the Charles River Basin wetlands, Massachusetts, US [13]

The Charles River Basin wetlands in Massachusetts consist of 3,455 hectares of freshwater marsh and wooded swamp. This is 75% of all the wetlands in Boston's major watershed. The benefits derived from these wetlands include flood control, amenity values, pollution reduction, water supply and recreational opportunities. Estimates of economic values derived from these wetlands are presented in Table 6.

Table 6:
Economic Value of Charles River Basin wetlands, Massachusetts, US

Economic Benefit	Economic Value per year (converted to 2003 US$)
Flood damage prevention	39,986,788
Amenity value of living close to the wetland	216,463
Pollution reduction	24,634,150
Recreational value: Small game hunting, waterfowl hunting	23,771,954
Recreational value: Trout fishing, Warm water fishing	6,877,696
TOTAL	**95,487,051**

Below: *Varzea Flooded Forest, at almost the height of the annual flooding period, is a breeding ground for more than 200 fish species Amazonas, Brazil.*

Global Economic Values

The previous examples have highlighted the enormous economic values of individual wetlands. The economic value of most wetlands, however, are not known and therefore not included in decisions regarding wetland use, conservation or restoration. This is often at the basis of many threats facing wetlands. In response to this, there has been a large research effort to estimate the economic value of selected wetlands around the world. Drawing on the results of a statistical synthesis (or 'meta-analysis') [14] of this available literature, which includes economic valuation studies of 89 wetland sites (see Appendix 1 for a list and map of the 89 wetland sites), we are able to initially examine the global economic value of wetlands (see Appendix 2 for a brief summary of the meta-analysis).

The estimates provided in this section highlight the economic values of global wetlands and further substantiate the need for more sustainable management of these wetlands. The values illustrate how much wetlands can be worth economically and represent initial estimates of costs to society if these wetlands are lost. Although many of the threats facing global wetlands are rooted in poverty and high demographic growth rates, it is often the case that decision-makers either neglect or underestimate the values of conserving wetlands as opposed to the allocation of wetland areas and water to other purposes. The types of economic values estimated in this section can provide powerful arguments to these decision-makers and show how conservation and wise use of wetlands is in the economic interest not only of local populations dependent on these wetlands for their livelihoods but of society as a whole.

First, to summarize the information on wetland values found in the literature, the median economic values by wetland type have been estimated. This is presented in Table 7. Here we use five wetland categories, based on the categories used in the literature: mangroves, unvegetated sediment (for example inter-tidal sand and mudflats such as the Dutch Wadden Sea or the Rufiji delta in Tanzania), salt and brackish marsh, freshwater marsh, and freshwater wooded wetlands (for example temporarily inundated floodplain forests and swamp forests). **Note that rivers and floodplains are not included in this study - specific studies on the economic value of rivers still need to be undertaken**. Table 7 shows that, based on the sample of 89 case-studies, unvegetated sediment wetlands are found to have the highest values, followed by freshwater wooded wetlands ($374 and $206 per hectare per year respectively). These differences in per hectare values across wetland types are partly explained by the differences in the wetland functions that have been valued in these wetlands. Unvegetated sediment has largely been valued for its provision of storm protection, recreational opportunities and its role as a nursery ground for commercial fisheries – all highly valued services. Mangroves, on the other hand, have been valued for the provision of the full range of wetland services, but mostly for the provision of materials such as timber and fuel wood. Differences in income levels may also explain the low value of mangroves, in that most mangrove valuation studies are for developing countries in South-East Asia.

Table 7:
Median Wetland Economic Values by Wetland Type

Wetland Type	Median Wetland Economic Value (US$ per hectare per year, 2000)
Unvegetated Sediment	374
Freshwater Wood	206
Salt/Brackish Marsh	165
Freshwater Marsh	145
Mangrove	120

Secondly, Table 8 presents the median economic value for each of the selected wetland functions, to be interpreted as the annual value of the wetland function derived from one hectare of wetland[5]. As can be seen, **these functions are not distinguished for specific regions or wetland types and it must, however, be kept in mind that many functions are characteristic of specific wetlands within specific regions**[6]. It can be seen in the table that, based on the sample of 89 case-studies, the provision by wetlands of recreational opportunities and amenities, flood control and storm buffering are the highest valued wetland services. Note that highly valuable wetland services like climate regulation and potential value to tourism are amongst the functions not taken into consideration in this study due to lack of reliable data so far available. The provision of materials such as food, thatch, timber and fuel wood are the lowest valued wetland functions.

Table 8:
Medium Wetland Economic Values by Wetland Function

Wetland Function	Median Wetland Economic Value (US$ per hectare per year, 2000)
Flood Control	464
Recreational Fishing	374
Amenity/Recreation	492
Water Filtering	288
Biodiversity	214
Habitat Nursery	201
Recreational Hunting	123
Water Supply	45
Materials	45
Fuel wood	14

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Third, using the same estimates of economic values from the 89 wetland case studies found in the literature we may attempt an extrapolation to the economic value of other wetlands around the world, keeping in mind that this is initial and would need further data to be refined. To do this we carried out a 'value transfer', which involved the prediction of the value of a wetland, given the knowledge of its physical and socio-economic characteristics[7]. We performed this to an inventory of around 3,800 wetland sites around the world, taken from the CCRU Global Wetland Database[15], to provide an initial estimate of the global economic value of wetlands. This inventory of wetland sites is certainly far from comprehensive but is currently the best available database of global wetland areas[8]. To carry out a value transfer we needed information on specific characteristics of each wetland, such as wetland type, wetland area and latitude, as well as imputed information on per capita income and population density[9]. Table 9 shows the area of wetland represented in this inventory by continent and wetland type. The total area of wetlands around the world on which the economic value estimates that follow are based amounts to **approximately 63 million hectares**. Due to the limited wetland area covered by this database, the following value estimates are very conservative.

[5]The wetland functions included in Table 8 are not as comprehensive as the list of functions outlined in Box 1, but reflect the distinctions that are generally made between wetland functions in the economic valuation literature. The wetland function of supporting fisheries, both within and outside the wetland is included in the "habitat and nursery" function in Table 8.

[6]For example, recreational fishing is a function that is dominant in wetlands in Europe and the United States, but not in many tropical wetlands.

[7]See the Appendix for a description of how the value transfer was performed.

[8]The main limitations of this database are that it only includes coastal wetlands and does not include mangroves, rivers and floodplains. Hence, freshwater wetlands are under-represented as compared to their global coverage. To deal with the exclusion of mangroves, approximately 130 mangrove sites were added to this inventory from the Ramsar database.

[9]The Ramsar database also contains this information but includes a smaller number of wetland sites and covers a smaller wetland area.

Table 9:
Total Area of Wetlands by Continent and Wetland Type (1000 ha).

	Mangrove	Unvegetated. Sediment	Salt/Brackish Marsh	Freshwater Marsh	Freshwater Woodland	TOTAL
N America	510	16,906	2,575	192	3,258	**22,931**
Latin America	4,224	9,223	1,707	289	1,010	**12,230**
Europe	0	2,374	500	66	330	**3,271**
Asia	1,439	8,011	1,027	2	657	**9,697**
Africa	3,686	4,632	487	48	310	**5,477**
Australasia	2,253	4,641	461	167	4,090	**9,361**
TOTAL	**12,112**	**45,788**	**6,758**	**765**	**9,657**	**62,967**

Table 10 presents the global economic values of wetlands, aggregated by wetland type and continent. The total economic value of 63 million hectares of wetland around the world is estimated at **$3.4 billion per year**. The table also illustrates that, based on the sample of 89 case-studies, wetlands in Asia have the absolute highest economic value at $1.8 billion per year. The high value given to Asian wetlands in this study could be explained by the high population density in most Asian countries. Large populations tend to mean high demand for wetland goods and services, and hence higher economic values. However, high populations may also correspond to a higher pressure on the biodiversity, scientific, socio-cultural and other important wetland values as well as the integrity of ecological processes provided by the wetland. Other reasons are the intensity of use of Asian wetlands (all available wetland functions are utilized) and their relative scarcity (the lower the wetland area available, the higher the average value of the remaining wetland areas). Latin American wetlands have lower values for precisely the opposite reasons. Population density is generally low in Latin American countries and there is a relative abundance of wetland area. Such wetlands, however, may have higher biodiversity, scientific, socio-cultural and other important wetland values. Therefore, **it should be kept in mind that wetlands should not be conserved and managed based on their economic values alone**. Lower economically valued wetlands should be conserved for their high biodiversity, ecological and socio-cultural values, values that must also be integrated in decision-making processes. Lastly, the table also shows that based on the sample case-studies unvegetated sediment wetlands have the highest economic value at $2.8 billion per year. This high value in this study may result from the large area of this wetland type in the inventory of global coastal wetlands.

Table 10:
Total Economic Value of Global Wetlands by Continent and Wetland Type (thousands of US$ per year, 2000)

	Mangrove	Unvegetated. Sediment	Salt/Brackish Marsh	Freshwater Marsh	Freshwater Woodland	TOTAL
N America	30,014	550,980	29,810	1,728	64,315	**676,846**
Latin America	8,445	104,782	3,129	531	6,125	**123,012**
Europe	0	268,333	12,051	253	19,503	**300,141**
Asia	27,519	1,617,518	23,806	29	149,597	**1,818,534**
Africa	84,994	159,118	2,466	334	9,775	**256,687**
Australasia	34,696	147,779	2,120	960	83,907	**269,462**
TOTAL	**185,667**	**2,848,575**	**73,382**	**3,836**	**333,223**	**3,444,682**

The total economic value of wetlands illustrated in table 10 is a very conservative estimate. There are several reasons for this. The first reason is that many functions of wetlands were not included simply because they were not valued in the economic valuation studies collected. Comparing Table 8, for example, with Box 1 shows that wetland functions such as water supply (extractive use by industry), erosion control, climatic stabilization, carbon sequestration, maintenance of ecosystem stability, medicinal resources and genetic resources were not included in this economic valuation study, while values used were for flood control, recreational fishing, amenity/recreation, water filtering, biodiversity, habitat nursery, recreational hunting, water supply (agriculture), materials, and fuel wood.

The second reason for the very conservative estimate of global wetlands is that the total area of wetlands valued amounts to only 63 million hectares. It was discussed above why this limited area was used. The actual global total wetland area is much larger. One study ([28]) predicts the total area of global wetlands to be 12.8 million km^2 (or 1,280 million hectares), but also found that global wetland inventories were incomplete and unreliable. Another study [29] estimates the total area of the world's wetlands to be around 8-10 million km^2 (or 800-1,000 million hectares). **These areas amount to thirteen to twenty times the area that we were able to use for the value transfer to derive the $3.4 billion figure**. Assuming that the wetland inventory that we used for the value transfer is a representative sub-set of global wetlands we are able to scale up the $3.4 billion estimate to provide a rough extrapolation of the magnitude of global wetland economic value. **If we take the estimate cited by Ramsar of global wetland area at 12.8 million km^2, the total economic value of the world's wetlands based on the functions examined in this report and therefore not all functions could be around $70 billion per year.** The numbers presented in this section should be interpreted as order of magnitude of economic value, based on a snapshot of available data on wetland areas and case studies of wetland economic values, and could be enhanced as more data becomes available.

Below: *Young boys fishing in Wilkowo, Danube floodplain, Ukraine.*

Status Summary of the World's Wetlands

Major Threats to Wetlands

Despite their importance and value, as was illustrated in the previous sections, wetlands around the globe are being modified or reclaimed – either their resources are over-exploited, their lands are converted to other uses, or upstream developments alter the quality and flow of water feeding the wetlands. A major factor contributing to these activities is that decision-makers often have insufficient understanding of the economic values of wetlands, in which case the protection of wetlands may not appear to be a serious enough alternative. Wetlands are often perceived to have little or no value compared to other uses of its lands and water that may yield more visible and immediate economic benefits. These other uses, such as the draining of wetlands for irrigation and agriculture and using the wetlands waters for electricity generation, constitute the **opportunity cost of wetland protection**. Decision-makers still often perceive these opportunity costs, together with other costs of wetland protection, as exceeding the longer term and more general benefits of wetlands.

Since 1900, more than half of the world's wetlands have disappeared (Barbier, 1993). These losses are generally caused by: (1) the fact that many wetland products and services are public goods and don't have clear property rights; (2) external costs that are imposed on stakeholders of wetlands; and (3) policy intervention failures due to a lack of consistency among government policies in different areas, including economics, environment, nature protection and physical planning [16]. In the United States, it is estimated that 54% of original wetlands have been lost, 87% of which to agricultural development and 8% to urban development [17]. Box 2 illustrates wetland loss and its consequences in the United States with an example of the Everglades in Florida, illustrating the immense cost in money and time of trying to restore them [32]. In France, 67% of wetlands have been lost in the period 1900 to 1993, while the Netherlands have lost 55% of wetlands in only 35 years between 1950 and 1985. Although some past conversions might have been in society's best interests, wetlands have frequently been lost to activities resulting in limited benefits or costs to society [16].

Box 2:
Loss of the Everglades

The dramatic increase in human population together with its associated development has greatly stressed the Everglades in the state of Florida in the United States. Half the original wetlands are gone, and the remaining habitats are altered and dissected by canals, roads, and other man-made features. Urban storm water and agricultural practices have polluted Lake Okeechobee and disrupted the ecological balance of nutrients in wetlands to the South. Some key losses to the Everglades ecosystem are:

- *50% reduction in area of the Everglades;*
- *90-95% decrease in wading bird populations;*
- *68 threatened or endangered species;*
- *2,467 million m^3 of water lost from the system through discharge and unnatural seepage annually;*
- *increased unnatural discharges of freshwater have damaged coastal estuaries;*
- *the incidence of coral diseases has increased 10-fold since 1980;*
- *4,047 million m^2 of the system under health advisories from mercury contamination;*
- *phosphorus contamination of Lake Okeechobee, the Everglades, and surrounding wetlands;*
- *the rampant spread of invasive exotic species and the displacement of native species;*

Rapid population increase, development, and urban sprawl along the state's coastal areas have stressed the human environment around the Everglades. Agricultural areas face related problems stemming from growth and urban sprawl. It is expected that by 2050, South Florida's population will increase threefold, from 5 million to 15 million. This will result in an increased demand for roads, utilities, and services in response to outward growth of suburbs, and overly stressed infrastructures. Similarly, high population growth rates will result in greater unemployment, lower income and education levels, and a high prevalence of poverty in urban cores. Key losses to the human environment in the Everglades include:

- *16% reduction in agricultural lands;*
- *high numbers of sites contaminated by hazardous materials (brownfields);*
- *repetitive water shortages and salt water intrusion;*

***A restoration plan for the Everglades is underway, called the Comprehensive Everglades Restoration Plan (CERP). The estimated costs are $7.8 billion, split between the Federal Government and the State of Florida. Over the next 38 years, engineers and ecologist will attempt to repair the damage caused by a century's worth of drainage and redirect water lost to tide back into the Everglades**, requiring a delicate balancing between demands for water supply and flood protection on one hand and ecological restoration on the other.*

Source: Working group of the South Florida Ecosystem Restoration Task Force, 1998

At the root of these wetland conversions is the fact that numerous stakeholders of wetlands with different interests lay claims on the wetlands' functions that don't always coincide. Although every wetland will have a different set of stakeholders, a total of nine different groups of stakeholders have previously been identified across wetlands (see Box 3). In many cases, it is likely that the different interests of these stakeholders result in conflicts, so that policy-makers are faced with complex trade-offs.

Box 3:
Stakeholders of Wetlands

Direct extensive users	*directly harvest wetland goods in a sustainable way.*
Direct intensive users	*have access to new technologies that allows to harvest more intensively.*
Direct exploiters	*dredge sediments in the wetland, or exploit mineral resources, clay, peat and sand without a direct concern for the health of the environment.*
Agricultural producers	*drain and convert wetlands to agricultural land.*
Water abstractors	*use wetlands as sources of drinking water, agricultural irrigation, flow augmentation, and so on.*
Human settlements close to wetlands	*wetlands as sites for human settlement expansions.*
Indirect users	*benefit from indirect wetland services, such as storm abatement and flood mitigation.*
Nature conservation and amenity groups	*groups whose objective is to conserve nature and groups who enjoy the presence of plant and animal species.*
Non-users	*users that may attribute an intrinsic value to wetlands.*

Turner et. al. (2000) [16]

Water management in wetlands has often been oriented solely towards the needs of people, such as transportation, agriculture, flood control and settlement. Instead of an integrated approach towards management of freshwater ecosystem and resources, known as the 'ecosystem approach (see COP 8, Doc 32) in which the ecosystem and its different stakeholders play a key role, wetlands have been transformed by a wide variety of human uses. In this respect, several engineering techniques have been applied [4]. First of all, for the purpose of embankment and water retention, man may

Below: *Stall specialised in the sale of freshwater Crayfish. Beijing, China.*

Above: *Loading reeds onto a boat which will transport them to one of the paper mills along the lake shore in Hunan Province.*

construct dikes, dams and reservoirs in rivers and other wetlands. These may prevent flooding, promote storage for drinking water or irrigation, or produce electricity. For example, there are currently more than 45,000 dams in the world, which withdraw around 3,800 km^3 of fresh water annually from the world's rivers, lakes and aquifers [19]. Secondly, lakes, rivers or canals in wetlands may be subject to dredging (as a result of siltation, which is often caused by upstream ecosystem degradation, including deforestation), excavation and deepening, to prevent flooding or, for example, to eliminate shallow water bodies favourable for water-related diseases. Third, canalization of waters in wetlands is aimed at the improvement of flows within a river basin or to transfer water to an area where water demand is high. A fourth activity that affects wetlands is drainage. Drainage of polders or fields is carried out through, for example, pumping or gravity drainage. The activity may also be carried out to create new land for agricultural, industrial or urban purposes. Fifth, in the field of water supply, activities such as exploitation of surface water and groundwater through for example pumping or excavation may be distinguished. Lastly, different types of irrigation schemes and techniques require total water control and therefore may have serious adverse effects on wetlands. The results of these human interventions often alter the functioning and natural evolution of a wetland, thereby eliminating its potential benefits.

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In Africa, as in many developing countries, common factors that put further increasing pressures on wetlands are poverty in combination with high population growth rates [20]. Poverty results in situations where a wetland's resources may be the only source for survival for communities in terms of food, water and shelter. Since most wetlands' resources are often common-property, overpopulation results in over-utilization of these wetland goods and services. Such stresses are often compounded by drought. Wetland loss in these countries is furthermore often increased by the disparity between those who make decisions about the allocation of a wetland's land and water on the one hand, and those that depend on the wetland's goods and services for their livelihoods on the other hand. For example, decision-makers can often derive higher profits from the utilization of water from rivers that feed wetlands for irrigation or hydropower, while the costs of these conversions are borne by large amounts of local communities. They pay with a decrease in their livelihoods.

The root cause of much wetland degradation, however, is **information breakdown**. This relates to the complexity and invisibility of relationships among groundwater, surface water and wetland vegetation [16], the failure to understand the consequences of land use, water management, pollution and infrastructure on wetlands, and the fact that many wetland functions do not have a market price and as such are not recognized as having an economic value by decision-makers. As a result, benefits of wetland conversion such as extensive crop production and power generation are often perceived to have more economic benefits than the conservation and sustainable management of wetlands themselves. Reasons are that such benefits often appear in the short term and are readily available in monetary terms. These benefits, however, are also costs society must bear in the form of the loss of important wetland functions that often appear in the long-term and are not readily available in monetary terms. However, there is an increasing trend towards restoration of wetlands, including decanalization of rivers, rehabilitation of degraded floodplains, decommissioning of dams and so on, especially in industrialized countries. Several countries are now investing huge sums of money in the restoration of wetlands they had first spent tens or even hundreds of millions of dollars on to reclaim or canalize. In the Rhine river basin, for example, $1.8 billion is being invested as part of the 'Room for the Rhine Project' for the period 2015-2050, a project aimed at managing floods by bringing back the ecological functions of the Rhine delta (reserving retention areas and giving the river more space for natural flooding on the sides) [21]. Such investments of restoring wetlands are huge long-term costs of wetland loss and rarely produce a perfectly re-established ecosystem with ecological processes comparable to the original or natural ones.

Current Situation, Future Prospects and the Importance of the Ramsar Convention

In the previous section, it was explained how pressures on wetlands have principally been economic or financial. Apparent benefits received from activities that alter or injure the status of wetlands seemed to have overshadowed the economic benefits of the protection of wetlands. A major factor contributing to these activities is that the perspective towards the environment in this time period was still one of unlimited exploitation for human needs. Since then, our knowledge and information about the environment, about the effects of human actions on the environment and about ecological relationships have improved. This has led to changing perspectives on the relationship between people and the environment in many countries. As a result, it is increasingly being recognized that humans depend on ecosystems for their survival.

In 1975, the Convention on Wetlands of International Importance entered into force. Interestingly, wetlands are the only single group of ecosystems to have their own international convention [16]. This convention (also known as the Ramsar Convention after the Iranian city in which the treaty was signed) is an intergovernmental treaty at first aimed at the conservation and wise use of wetlands as a habitat for water birds. Since then, however, the Convention has developed to cover all aspects of wetland conservation for biodiversity and well-being of human communities. In December 2003, the Ramsar database (at www.ramsar.org) listed 138 contracted parties with 1328 wetland sites[10]. Between mid-1999 and December 2003, WWF alone has facilitated around 28% of all Ramsar designations done since the birth of this convention. The distribution of Ramsar sites around the world is presented in Figure 2.

Figure 2:
Global Distribution of Ramsar Sites

Source: Ramsar Convention Bureau, 2003 [6]

Although this and other conventions have significantly improved the status of wetlands around the world and the recognition of the importance of conserving and managing them sustainably, the present set of regulations does not seem to be sufficient [16]. Wetlands are still being degraded in many parts of the world. In Africa, for example, which still has a significant number of pristine wetlands left when compared to Europe or parts of North America, many wetland areas are still experiencing immense pressures [22]. Current major threats to these wetlands include drainage for agriculture and settlement, excessive exploitation by local populations and improperly planned development activities. For example, Djoudj National Park in Senegal is threatened by dikes and dams built on the Senegal river course for the promotion of rice agriculture in its valley. The seasonal water flow and quality of the fresh water has changed due to these activities, compounded by the use of fertilizers and pesticides to improve yields and control pests in rice fields [23]. In Lake George (Uganda), threats to the wetland come from pollution from copper and cobalt mines and uncontrolled charcoal burning which deplete tree resources [24]. In the ephemeral wetlands of central north Namibia, the major threat is rapid population growth that puts increasing pressure on the wetland resources [25].

As populations in developing countries are expected to keep growing at a high pace in the coming decades, pressures on wetlands will surely increase. However, more and more developing countries are joining the Ramsar Convention and applying its principles and objectives, indicating a growing commitment to sustainable wetland management. Execution of more economic valuation studies of wetlands can aid in the pursuit of sustainable wetland management by increasing awareness of wetland benefits.

[10] *The most common Ramsar sites are permanent freshwater lakes, non-forested peatlands, intertidal flats, coastal lagoons, shallow marine waters, permanent freshwater swamps, estuarine waters, permanent rivers and streams, and seasonal freshwater swamps (see www.ramsar.org).*

Conclusions and Recommendations

Wetlands are a very important source of natural resources upon which many rural economies and entire societies depend. Wetlands perform very important functions that supply goods and services that have an economic value, including food, medicine, building materials, water treatment and climatic stabilization. Despite this importance, however, wetlands all over the world have been modified and reclaimed - since 1900, more than half the world's wetlands have disappeared.

Above: *Jaú National Park, Amazonas, Brazil. Fish scientists (ichthyologists) verifying fish net in dry season.*

International conventions have improved the status of wetlands around the globe - in December 2003 the International Convention on Wetlands (Ramsar, 1971) had 138 Contracting Parties with 1,328 designated "wetlands of international importance" (also known as "Ramsar sites"), 28% of which were facilitated by WWF since 1999. However, the present set of global regulations still appear to be too weak - wetlands are still being degraded in many parts of the world. The root cause of much wetland degradation is information breakdown. Decision-makers often have insufficient understanding of the economic values of wetlands, so the protection of wetlands doesn't appear to be a serious enough alternative. Wetlands are often perceived to have little or no economic value compared to alternative use of its lands and water that may yield more visible and immediate economic benefits. There is therefore a real need to better and more widely estimate these economic benefits and to further highlight the economic and other values of wetlands to decision-makers.

This paper has addressed the economic values of global wetlands. Case studies of economic values of wetlands in each continent have been used to illustrate this economic value. Drawing on the results of a valuation literature of 89 cases, estimates have been derived for wetlands globally by geographical region and by wetland function. It was shown that, based on the sample of 89 case studies, unvegetated sediment wetlands like the Dutch Wadden Sea and the Rufiji Delta in Tanzania have the highest economic values at a median economic value of $374 per hectare per year. Furthermore, the provision by wetlands of recreational opportunities and amenities, and flood control and storm buffering are the wetland functions with the highest median economic values at $492 and $464 per hectare per year respectively. The economic value of wetlands per geographical region was also estimated, which showed that based on the sample of 89 cases, Asian wetlands have the highest economic values at $1.8 billion per year.

Lastly, an attempt was made at estimating the economic value of global wetlands, which showed that $3.4 billion is a very conservative estimate of this economic value as the estimate (1) does not include all wetland functions, and (2) is based on a sample area that is only a fraction of the world's global wetlands (63 million hectares), currently the most extensive database available. Applying this estimate to the global estimate of wetland coverage of earth at 12.8 million km^2, however, easily places the global wetland economic value at $70 billion per year. The report's conclusions are based on a snap-shot of available data on wetland economic values, and the report's conclusions could be enhanced as more data becomes available.

The estimates derived in this paper illustrate the magnitude of economic value of wetlands in addition to their biodiversity, scientific, ecological, socio-cultural and other important wetland values. **These estimates can be used to raise awareness with decision-makers about the economic benefits of conserving and sustainably managing wetlands as per the principles and objectives of the Ramsar Convention as opposed to their degradation, their reclamation and eventually the need for their costly restoration. Rather than mosquito-invested swamps, wetlands are highly valuable ecosystems on which large amounts of populations economically depend.** This message must be conveyed to decision-makers across the world so that they may recognize this economic value and put their efforts in more sustainable management of the world's wetlands to the benefit of society. **Efforts should include the conservation and wise use of wetlands through designating wetland sites under the Ramsar Convention; improving wetland sustainable management (including as an increasingly important means for poverty reduction) according to Ramsar objectives; the development of national wetland policies; and including the economic benefits of wetlands, in addition to their ecological and socio-cultural benefits, in decision-making processes.** At the same time, the research in this paper has touched upon another issue, namely the lack of adequate and comprehensive national wetland inventories. **In order to understand the range of values of wetlands and for decision-makers to include these values in their decision-making processes, efforts must be directed at such inventories of wetlands all over the world. Lastly, it is important that more economic valuation studies on wetlands be carried out to improve our knowledge and awareness of economic values of wetlands, including a comparative assessment on the cost of degrading and restoring these ecosystems and their natural functions.**

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Appendix 1:
Wetland Sites Used in the Meta-Analysis

List of 89 Wetland Sites

Country	Region	Wetland name (where available)
Angola, Zambia, Zimbabwe, Malawi, Botswana, Namibia, and Mozambique		Zambezi basin wetlands
Australia	Northern Australia	Herbert River District
Australia	NSW	Gwydir
Australia	NSW	MacQuirie marshes
Australia	Queensland	Moreton Bay
Australia	Victoria	Barmah-Millewa
Australia	Western Australia	Jandacot
Austria	Eastern Austria	Donau-Auen
Bangladesh	South West	Sundarban
Brazil	Upper Paraguay River Basin	Pantanal
Cambodia	Koh Kong	Koh Kapik
Cambodia	Koh Kong	Koh Sra Lao
Cambodia	Koh Kong	Lamdam
Canada	Alberta	
Canada	Ontario	Lake St Clair
Canada	Saskatchewan	
Canada	Southern Ontario	Walpole Island
Czech Republic	Moravia	
El Salvador	Gulf of Fonseca	El Tamarindo
Fiji		
Germany, Austria, Slovakia, Hungary, Croatia, Bulgaria, Romania, Ukraine	Eastern Europe	Danube floodplain
India	Madhya Pradesh	Bhoj wetlands (Upper and lower lakes)
Indonesia	Irian Jaya	Bintuni Bay
Indonesia	West Kalimantan	Danau Sentarum Wildlife Reserve
Indonesia		
Italy	Sicily	Vendicari
Malawi	South Malawi	Lake Chilwa wetland
Malaysia	Perak	Matang mangrove forest reserve
Malaysia	Sarawak	Sarawak Mangroves Forest Reserve
Mexico	Campeche	Laguna de Terminos
Mozambique	Zambezi river floodplain	Barotse floodplain
Mozambique	Zambezi river floodplain	Lower Shire wetlands
Mozambique	Zambezi river floodplain	Zambezi delta
Namibia, Botswana	Zambezi river floodplain	Chobe-Caprivi wetlands
Netherlands	North	Wadden Sea
Netherlands	South Flevoland	Oostvaardersplassen
New Zealand	North Island	Whangamarino
Nigeria	North East	Hadejia-Nguru
Nigeria	North East	Madachi, Hadejia-Nguru
Pakistan	Sind and Baluchistan provinces	Indus river delta
Philippines	Lingayan Gulf, Luzon	
Sri Lanka	Gampaha District	Muthurajawela Marsh
Sweden	Gotland Island	Martebo mire
Sweden	Gotland Island	
Sweden		
Tanzania	Rufiji district	Rufiji floodplain and delta
Thailand	Chanathaburi province	
Thailand	Phatthalung	Thale Noi
Thailand	Surat Thani	Po Village mangroves
Trinidad and Tobago	Trinidad	Carlibay, North of Couva River, Point Lisas Bay, Orange Valley, plus other areas
Trinidad and Tobago	Trinidad	Caroni Swamp
Uganda	Kampala District	Nakivubo
UK	East Anglia	Norfolk Broads
UK	Norfolk	Cley marshes
UK	Norfolk	Halvergate marshes
UK	North West Scotland	Flow country
US	Atlantic coast	Five mid-Atalantic estuaries: Delaware, Potomac, James, East River, Hudson
US	California	Kesterson
US	California	Los Banos
US	California	Mendota
US	California	Merced
US	California	San Joaquin Valley
US	California	San Luis
US	California	Volta
US	Florida	All coastal marshland
US	Florida	East coast

Country	Region	Wetland name (where available)
US	Florida	West coast
US	Florida	
US	Georgia	All coastal marshland
US	Georgia	Constructed wetlands in the Little River/Rooty Creek watershed (near Lake Sinclair)
US	Kentucky	Clear Creek
US	Kentucky	Clear Creek, Flat Creek
US	Kentucky	Flat Creek
US	Louisiana	All coastal marshland
US	Louisiana	All wetlands
US	Louisiana	Dulac
US	Louisiana	Grammercy
US	Louisiana	Louisiana coastal marsh
US	Louisiana	Terrebonne
US	Louisiana	Thibodaux
US	Louisiana	Total Louisiana coastal and freshwater wetland
US	Louisiana	
US	Massachusetts	Charles River Basin
US	Massachusetts	
US	Michigan	Lake St Clair
US	Michigan	Saginaw Bay
US	Michigan	

Country	Region	Wetland name (where available)
US	Minnesota	Ramsey county wetlands
US	Nebraska	
US	North Dakota	Alice wetland
US	North Dakota	Buchanan
US	North Dakota	Nome
US	North Dakota	Rush lake wetland complex
US	North Dakota	Tower City wetland
US	North Dakota	
US	Oregon	Mulnomah County, all wetlands
US	South Carolina	Francis Biedler forest
US	South Dakota	
US	Suffolk County, Long Island, New York	Peconic estuary system
US	Various States	
US	Virginia	Captain's Cove
US	Virginia	Chesapeake Bay
US	Washington	East Side Green River watershed
US	Washington	North Scriber Creek wetland
US	West Coast	Entire Pacific flyway
US	Wisconsin	
Vietnam	Mekong Delta	Minh Hai
Vietnam	Nam ha	Xuan thuy, Hai Hau, Nghia Hung

Map of 89 Wetland Sites

Appendix 2:
Summary of Methodology

Economic Valuation of Ecosystems

Economic values can be quantified, a process that is called economic valuation of ecosystems. For those wetland goods and services that are traded in the market place and whose prices are not distorted, market prices can be used as indicators for economic values. Often, however, most goods and services do not have a market price and shadow pricing techniques can be applied to determine their economic values. Economic theory distinguishes several shadow valuation methods. For example, a well-known method is called Contingent Valuation, which directly obtains consumers' willingness to pay for a change in the level of an environmental good, based on a hypothetical market. Another example of a shadow pricing method is the Travel Cost method. This method relies on individual valuations of environmental goods that are revealed in the travel costs made by consumers to obtain the environmental good, such as distance costs per kilometre travelled, time costs of the individual, and the entrance fee of the particular environmental good. See Barbier et al. [26] for a practical guide on wetland valuation.

Although application of economic valuation must be done with care[12], it has an important added value. In general, one can say economic valuation of wetlands has two benefits. First, economic valuation is important to highlight the relative importance of different economic activities that depend on wetland functions. In this way, it can make important contributions to management plans of wetlands. Secondly, economic valuation may be useful in countering arguments on wetland conservation. Putting a monetary value on activities can highlight the significance of wetlands for people and thus provide strong arguments for the conservation of wetland lands and water as opposed to reclamation or diversion. In both cases, monetary valuation is an important complementary assessment to other, qualitative assessments on wetland functions that cannot be monetarized.

Meta-analysis of Wetland Values and Value Transfer

This section provides a brief description of the meta-analysis of wetland valuation studies used in this report and a description of the steps taken in the value transfer to global wetlands. This research has, in part, been carried out within the project DINAS-COAST (Dynamic and Interactive Assessment of National, Regional and Global Vulnerability of Coastal Zones to Climate Change and Sea-Level Rise), which is funded by the EU Directorate-General Research under project number EVK2-CT-2000-00084. For a more comprehensive description of this meta-analysis and the issues and accuracy of value transfer we refer to Brander et al (2003) [14].

Meta-analysis is concerned with a quantitative analysis of statistical summary indicators reported in a series of similar empirical studies. In total, 197 studies related to wetland valuation were collected and of these, 89 contained suitable and sufficient information for the purposes of comparison in a statistical meta-analysis. From these 89 studies, we were able to extract 246 separate observations of wetland value. The maximum number of observations taken from one study is ten and the average number is approximately 2.7. Care was taken not to double count value estimates that are reported in more than one study, or to include estimates that were derived through value transfer from studies also included in our data set. It should be noted that the geographical distribution of observations in our sample reflects the practice and availability of natural resource valuation studies rather than the distribution of wetlands. North America, for example, is particularly well represented with just under half our data set comprising of observations from the US and Canada. The number of observations for each continent are: North American 114, South and Latin America 13, Europe 24, Asia 55, Africa 33, Australasia 7.

[12]See Schuijt (2003, pages 40-48) for an overview of limitations and applicability of economic valuation studies [30].

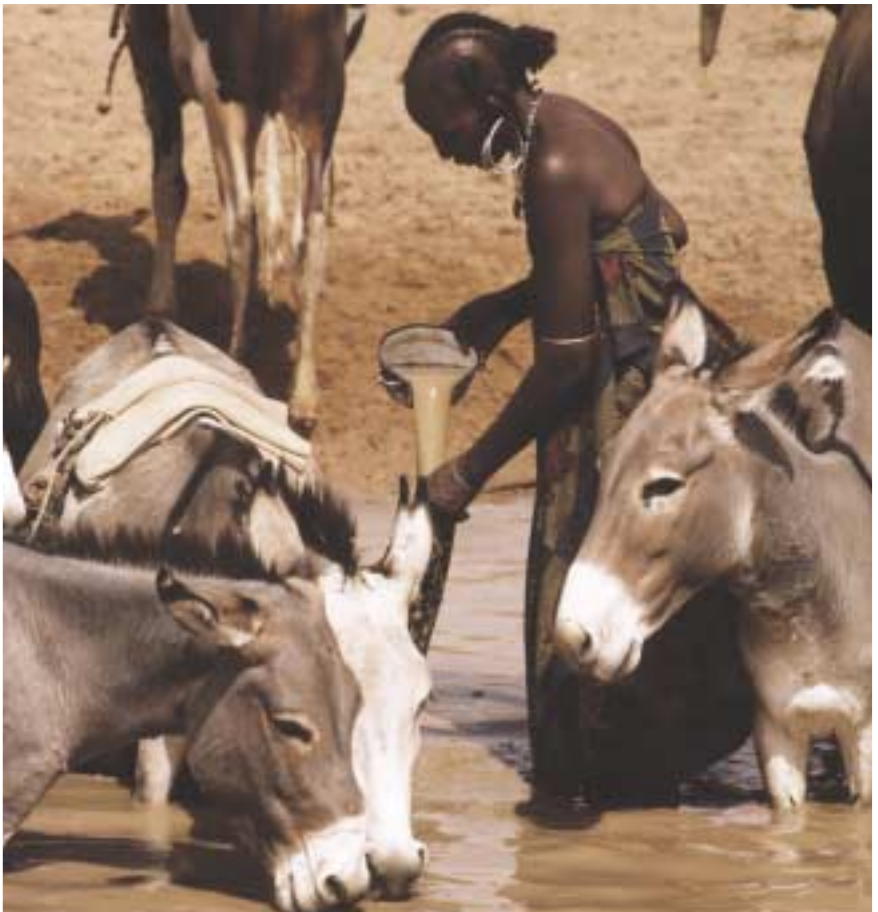
Wetland values have been reported in the literature in many different metrics, currencies and refer to different years (e.g., WTP per household per year, capitalized values, marginal value per acre, etc). In order to enable comparison between these values we have standardized them to 2000 US dollars per hectare per year. This standardization included a purchasing power parity (PPP) conversion in order to account for different price levels in different countries. For our data set the average annual wetland value is just over 3,000 US$ per hectare. The median value, however, is 170 US$ ha–1 yr–1, showing that the distribution of estimated values is skewed with a long tail of high values.

Given the existing number of wetland valuation studies there is substantial academic and policy interest in the potential for, and validity of, value transfer. Value transfer offers a means of estimating monetary values for environmental resources without performing relatively time consuming and expensive primary valuation studies. There are two general approaches to value transfer: direct value transfer and function value transfer. The first involves simply transferring the value(s) estimated in one or more primary studies to the policy site in question. Ideally, the study site and policy site should be similar in their characteristics, or adjustments should be made to the transferred value to reflect differences in site characteristics. The second approach involves transferring values to a policy site based on its known characteristics using a value transfer function, possibly estimated through a meta-regression. It is generally accepted that function transfers perform better than direct value transfers in terms of accuracy and it is this approach that we have used to transfer values to global wetlands.

We estimated a wetland value function by regressing the standardized wetland values on a number of important explanatory variables, including wetland type, income per capita, population density, wetland size and continent. Given information on the same characteristics of other wetland sites that are of policy interest, this estimated value function can then be used to predict the value of those wetlands. The inventory of global coastal wetlands that we use in this study contained information on wetland location, size and type. To this we added information on income per capita and population density at a country level from the World Bank World Development Indicators 2002.

It should be noted that value transfer may result in 'transfer errors', particularly when the characteristics of the site to which values are being transferred are not well represented in the data underlying the estimated value function. In the meta-analysis used in this report we have attempted to be as comprehensive as possible in our collection of valuation studies but clearly due to the availability of studies our sample focuses on certain wetland types, functions and locations. Value transfer estimates should therefore be treated with some caution, and for this reason we present wetland values at a somewhat aggregated level rather than for individual wetlands. Finally, one should always remember that economic value is only one component of its total value, which also includes biodiversity, scientific, socio-cultural and other important wetland values.

Below: *Peul (Wodaabe) lady filling waterskins at temporary pool, Central Niger*



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